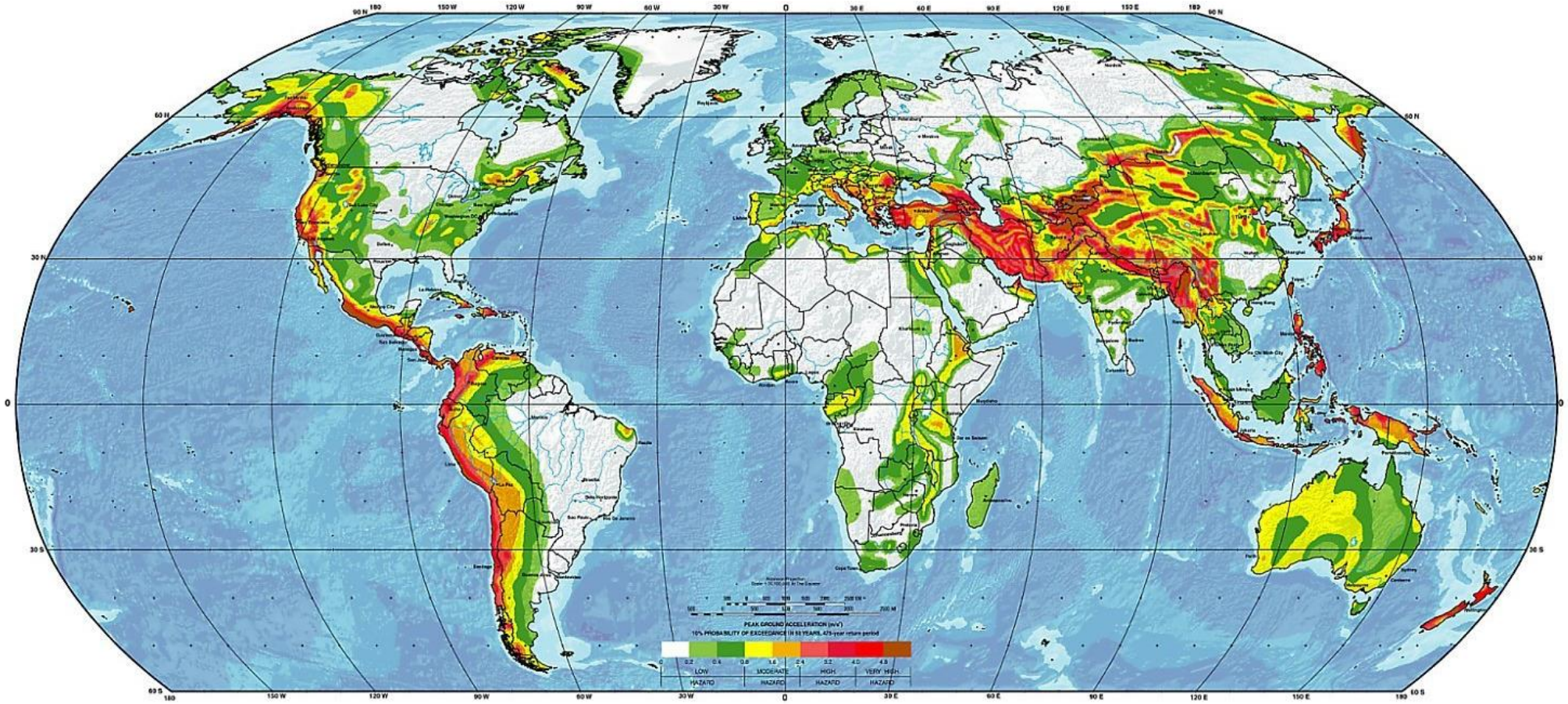
TMMOB İMO İSTANBUL ŞUBESİ

GÜÇLENDİRME PROJELERİNDE FİLİZ EKİMİ TASARIMI

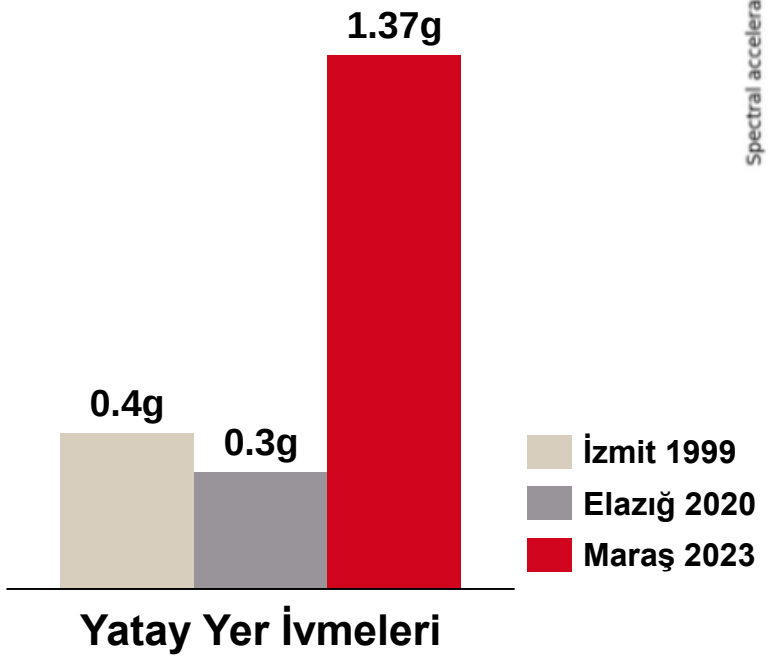
İnş.Müh.
Çağdaş Ilgaz Şenel

AJANDA

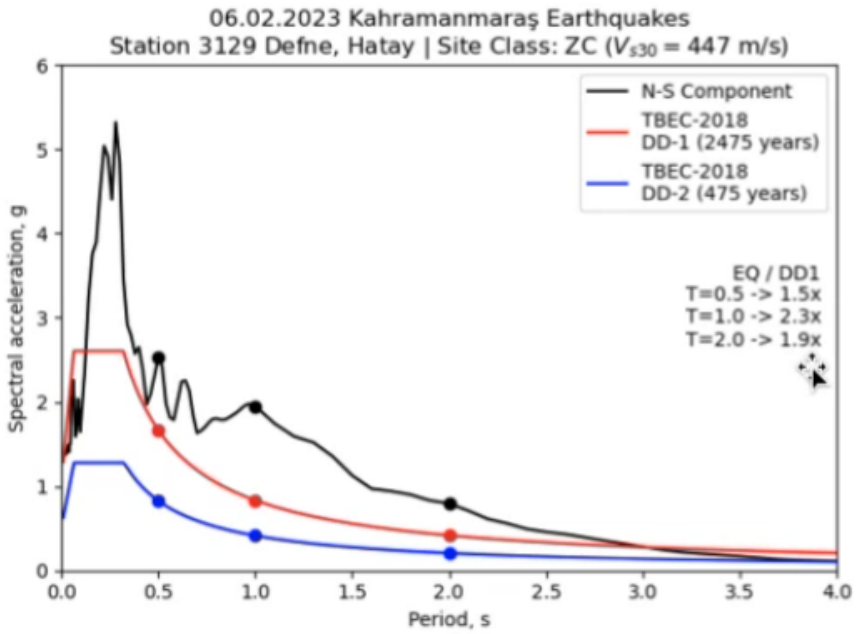
DEPREMLER – KAÇıNıLMAZ GERÇEĞIMIZ

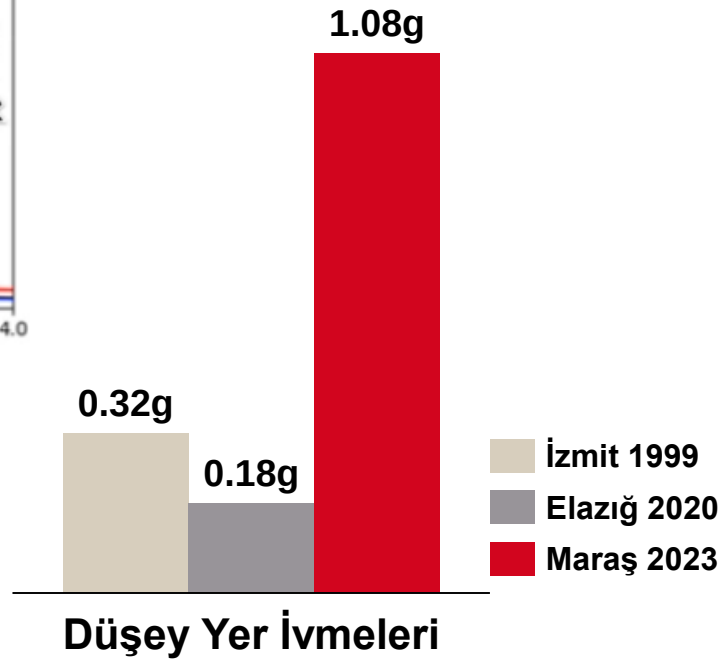


2023 DEPREMLERINDE ÇOK YÜKSEK YER IVMELERI GÖZLEMLEDIK



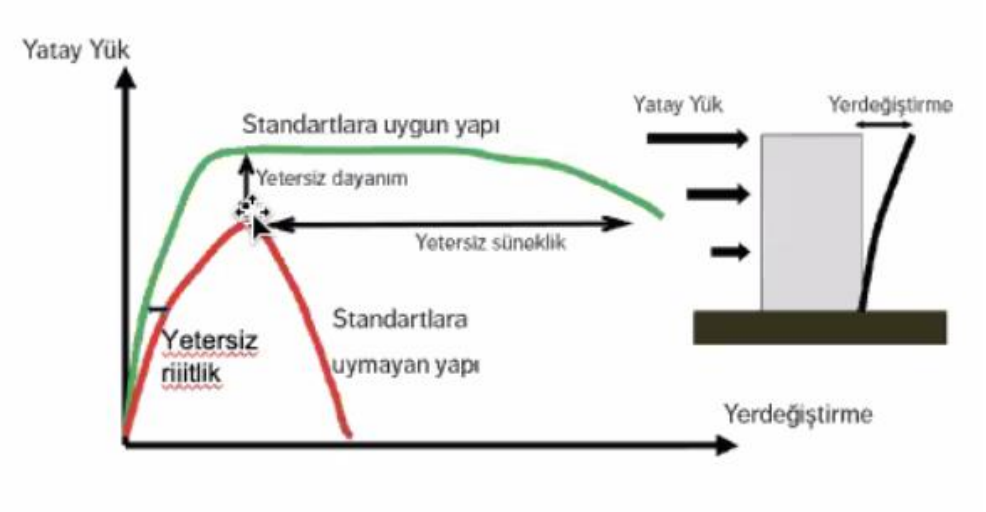
Yatay Yer İvmeleri





Düşey Yer İvmeleri

GÜÇLENDIRME YÖNTEMLERI



KAHOOT! ZAMANı

YAPISAL GÜÇLENDIRME ADIMLARI

1

Proje/Röleve

Mevcut yapının varsa projesine ulaşılır ve projeye göre imalat kontrol edilir, rölevesi çıkarılır.

2

Donatı ve Beton Özelliklerin Tespiti

Beton ve donatı özelliklerinin belirlenmesi; Paspayı Sıyırma *(TE 50, TE 60, TE 800 vb.)*
Tarama *(PS 300)*
Karot *(DD 160, DD 200)*

3

Performans Analizi

Toplanan veriler ışığında yapının deprem yönetmeliğine göre performansı incelenir.

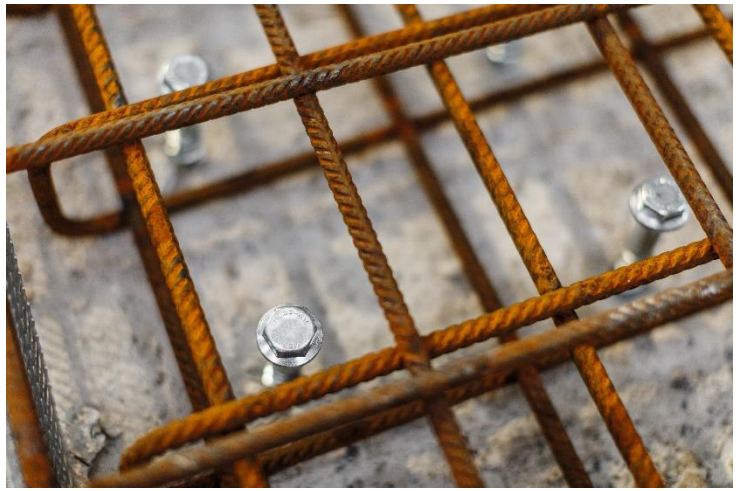
4

İşleme Karar Verilmesi

Güçlendirme yapılabilecek ise optimum metod seçilir. Tasarım deprem yönetmeliğine uygun şekilde hazırlanır.
Profis Engineering
RE 500 V4 (TR 069)

DONATı VE BETON ÖZELLIKLERININ TESPITI

KONVANSIYONEL GÜÇLENDIRME APLIKASYONLARı



AJANDA

ÇELIK (DONATı) YERLEŞTIRILIR, ÜZERINE BETON DÖKÜLÜR

Örnek:
Temel – Kolon Bağlantısı

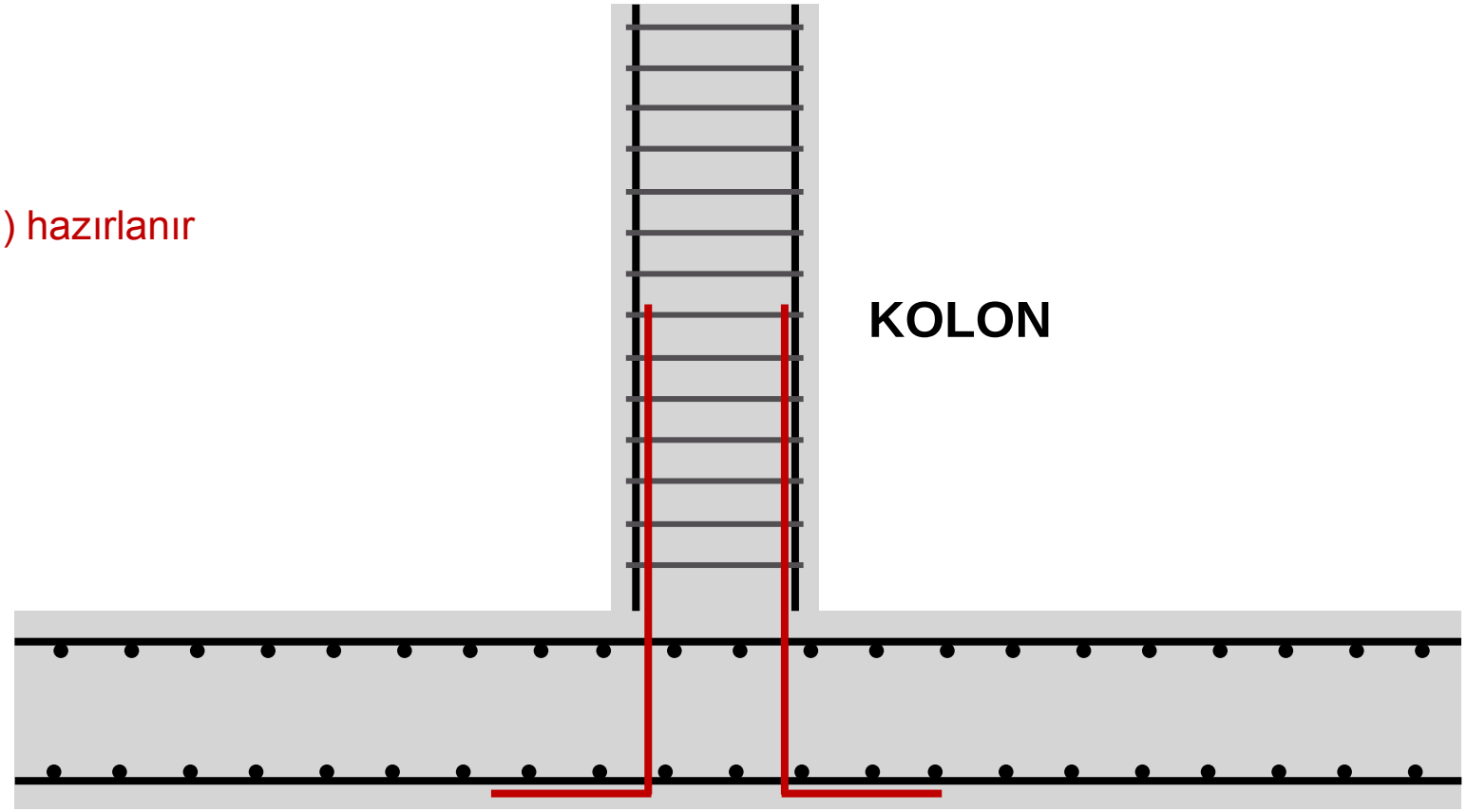
1) Temel donatısı hazırlanır

1') Kolon bağlantı donatıları (filizleri) hazırlanır

2) Temel betonu dökülür

3) Kolon donatıları hazırlanır

4) Kolon betonu dökülür.



BAĞLANTı DONATıLARı (FILIZLERI) SONRADAN KİMYASAL ANKRAJ İLE MEVCUT BETONA BAĞLANABİLİR

Örnek:

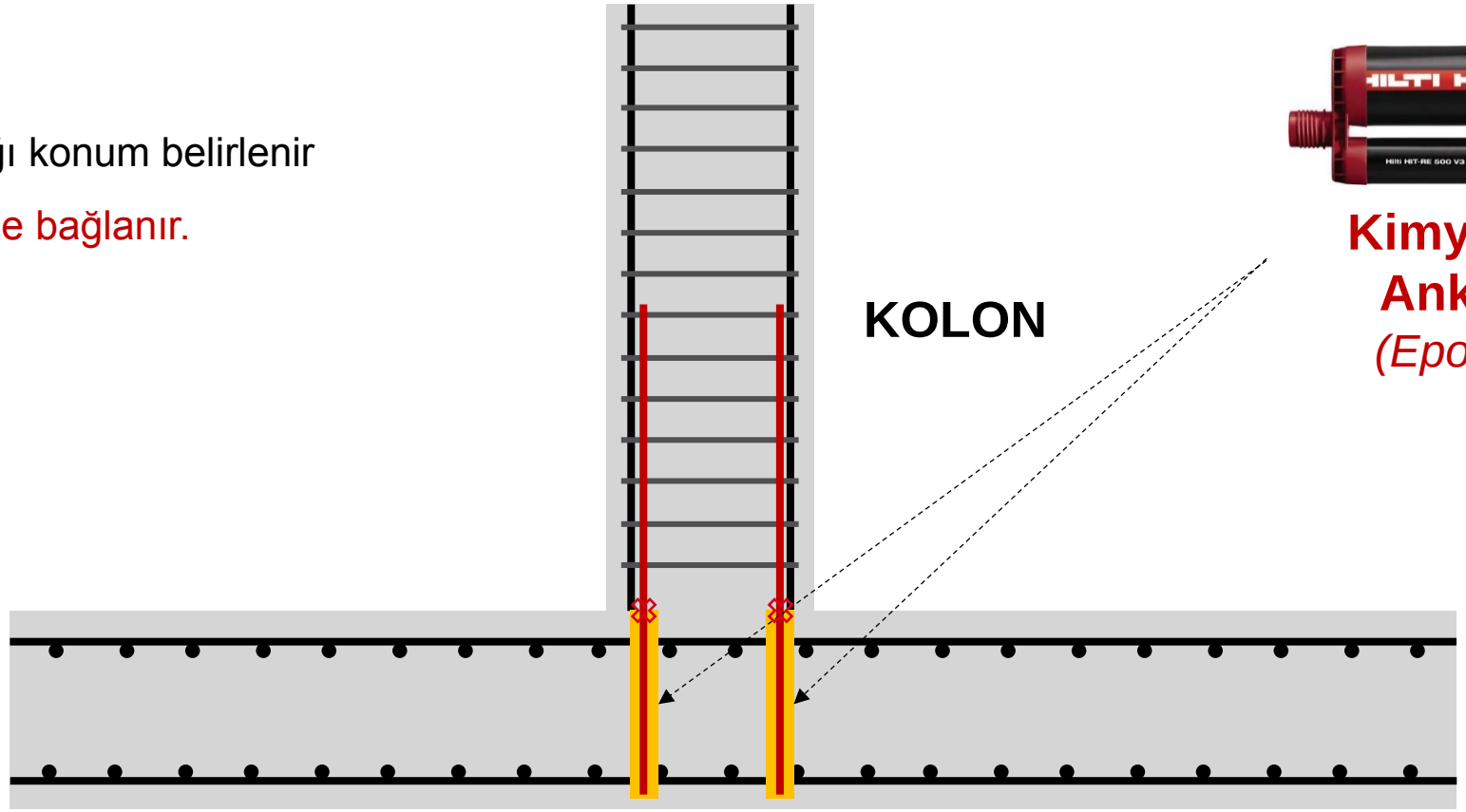
Temel – Kolon Bağlantısı

1) Bağlantı filizlerinin uygulanacağı konum belirlenir

2) Kimyasal ankraj ile filizler temele bağlanır.

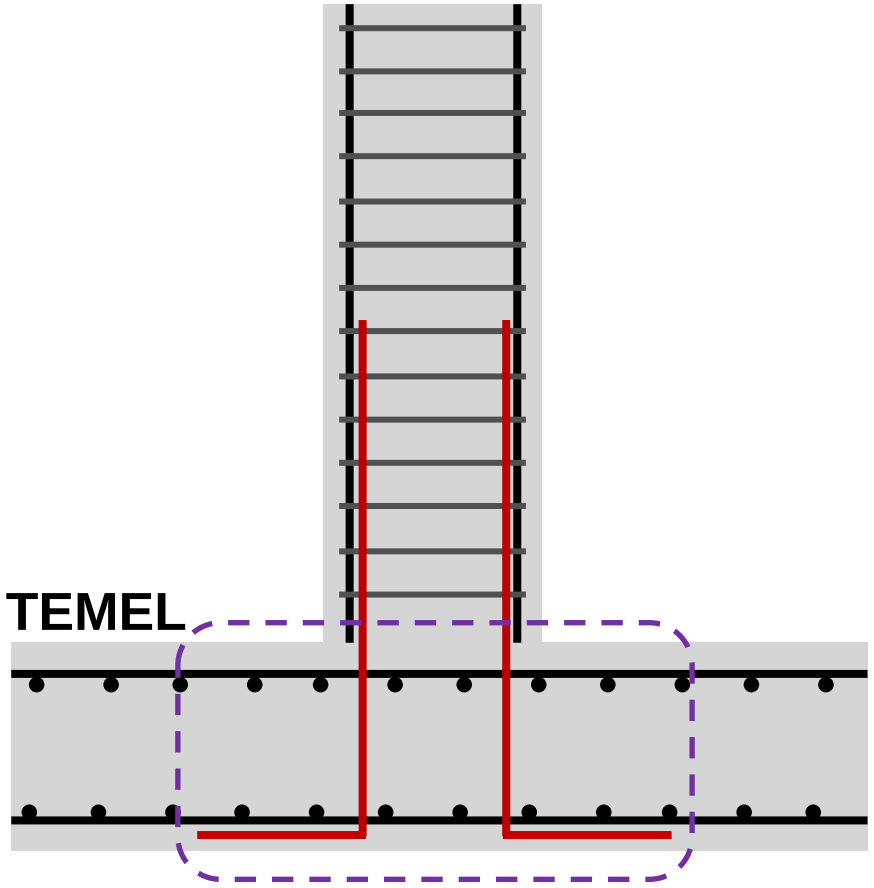
3) Kolon donatıları hazırlanır

4) Kolon betonu dökülür.

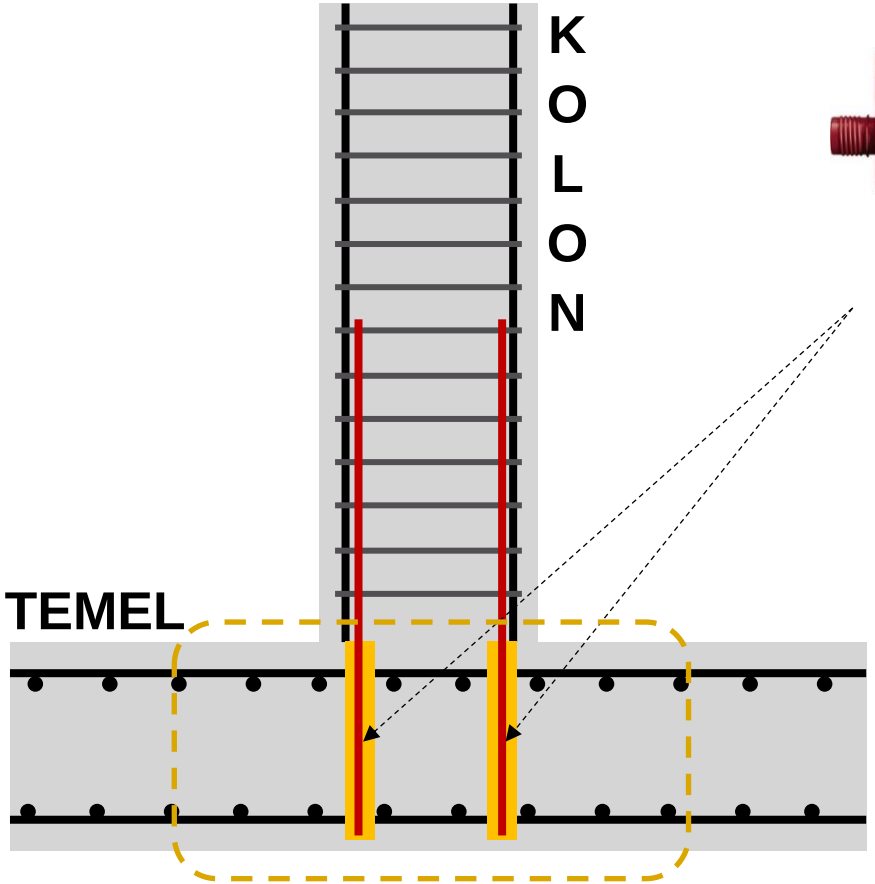


Kimyasal Ankraj
(Epoksi)

KİMYASAL ANKRAJ İLE FİLİZ EKİMİ YAPILARAK DA SİSTEM SÜREKLİLİĞİ SAĞLANABİLİR



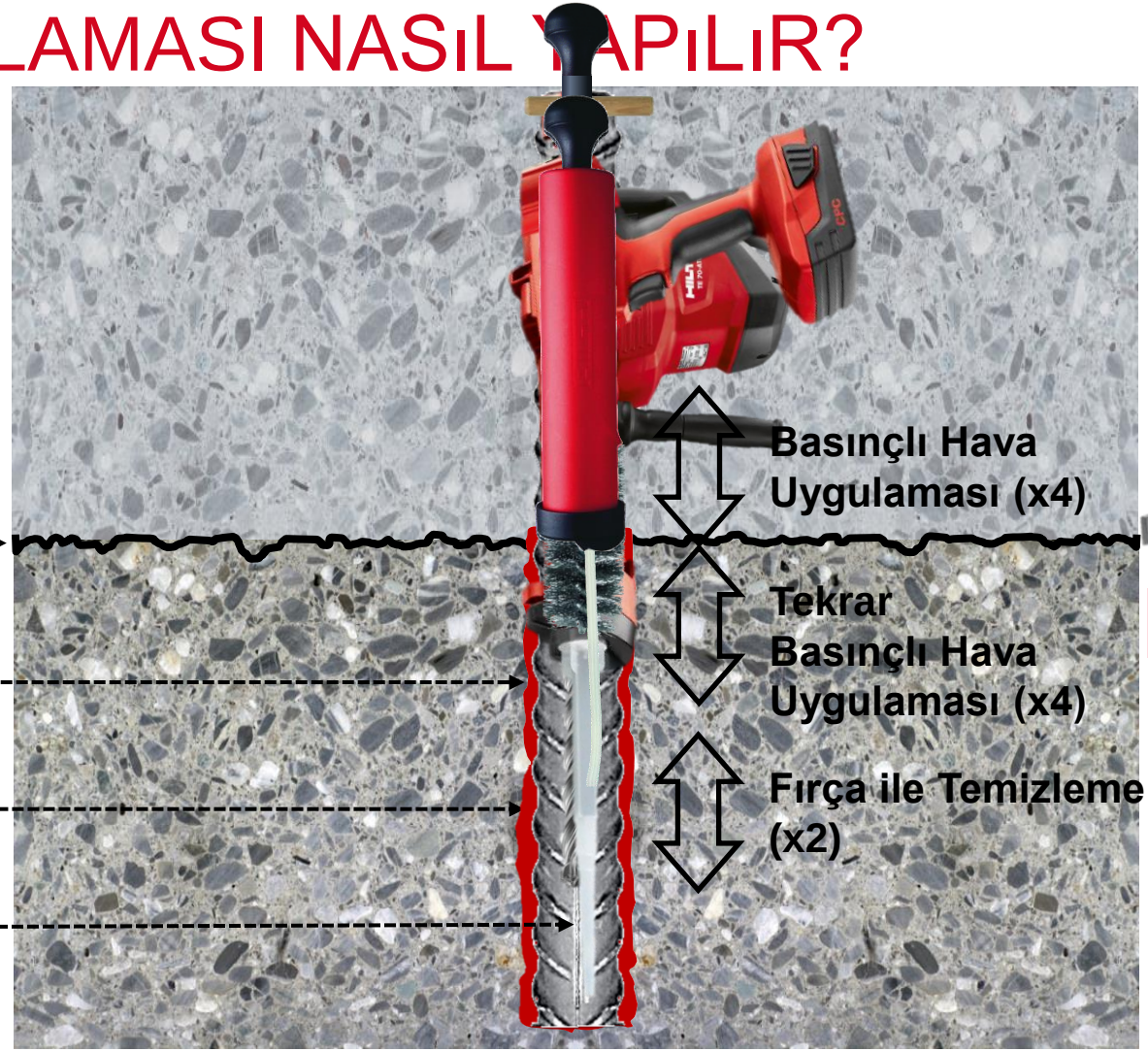
Filizlerin Yerinde Bırakılması Durumu



Filiz Ekimi Yapılması Durumu

Kimyasal Ankraj
(Epoksi)

FİLİZ EKİMİ UYGULAMASI NASıL YAPıLıR?

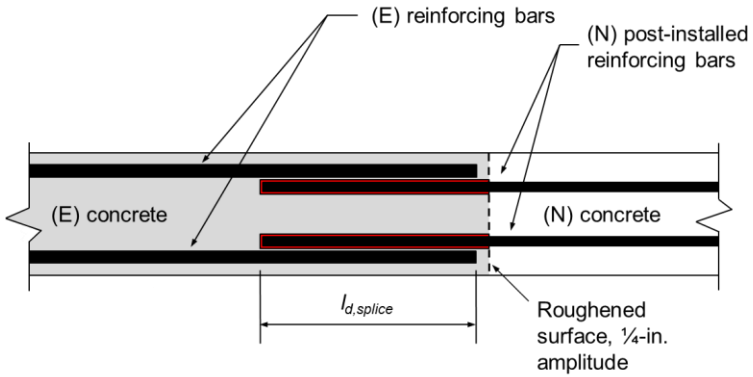


Yeni Beton

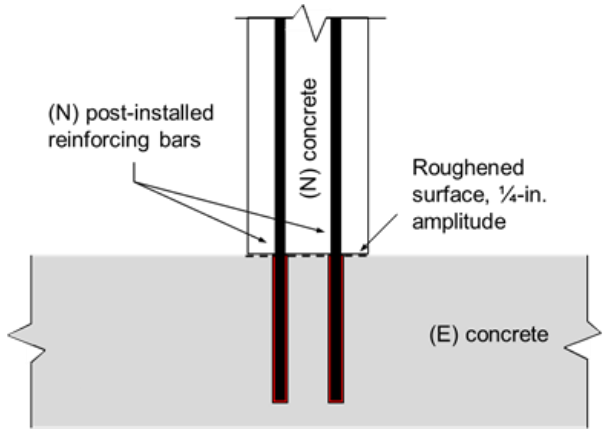
Mevcut Beton

TASARıM AÇıSıNDAN FILIZ EKIMI GENEL OLARAK 3 ANA GRUBA AYRıLıR

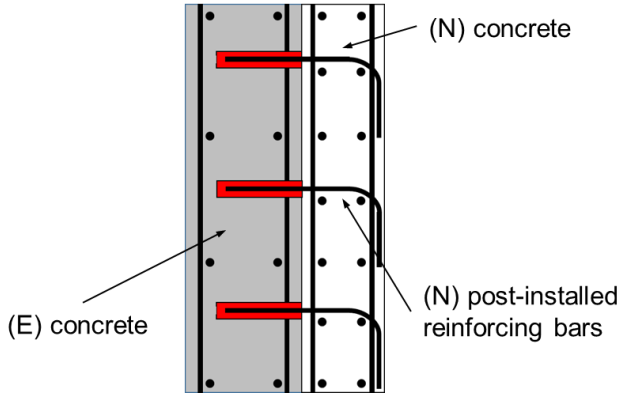
Bindirmeli Ekler (Splices)



Yapısal Ekler (End Anchorages)



Beton Kaplama (Concrete overlay)



KAHOOT! ZAMANı

FILIZ EKIMINDE BIR ÜRÜNÜN KULLANıLABILMESI IÇIN AVRUPA MEVZUAT YAPıSıYLA UYUMLU OLMASı GEREKIR

Avrupa Mevzuat Yapısı

Ürün Yeterliliği "EAD"

- "**European Assessment Document**"
  "Avrupa Değerlendirme Belgesi"

Bir yapı ürününün temel özelliğine göre performansının değerlendirilmesi için EOTA'da kabul edilen yöntemleri ve kriterleri" içerir.

Teknik Data "ETA"

- "**European Technical Assessment**"
  "Avrupa Teknik Değerlendirmesi"

İlgili Avrupa Değerlendirme Belgesine uygun olarak bir yapı malzemesinin performans değerlerini içerir.

Tasarım Yöntemi

- Tasarım yöntemi, betonarme tasarımı için teknik kuralları belirleyen Eurocode 2'ye dayanmaktadır.

- **EN 1992-1-1 / TS EN 1992-1-1**
- **EOTA TR 069**
- **EOTA TR 066**

AJANDA

1.0 Giriş ve Güçlendirme Adımları

2.0 Filiz Ekimi Nasıl Yapılır?

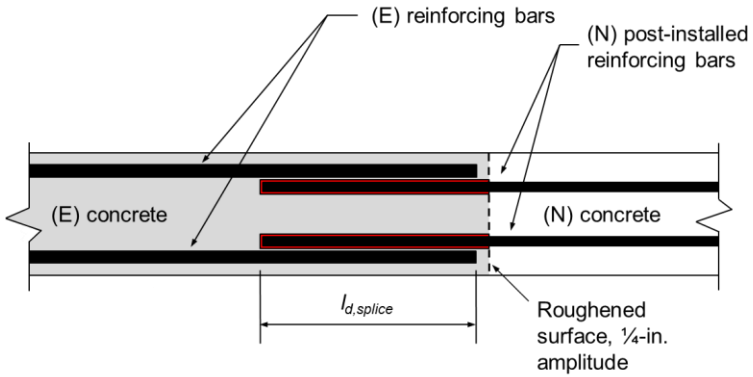
3.0 Bindirmeli Bağlantılar (Splices)

4.0 Yapısal Ekler (End Anchorages)

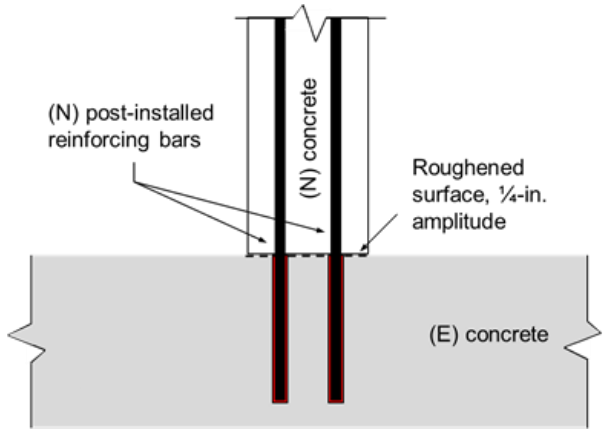
5.0 Kesit Kalınlaştırma (Concrete Overlay)

TASARıM AÇıSıNDAN FILIZ EKIMI GENEL OLARAK 3 ANA GRUBA AYRıLıR

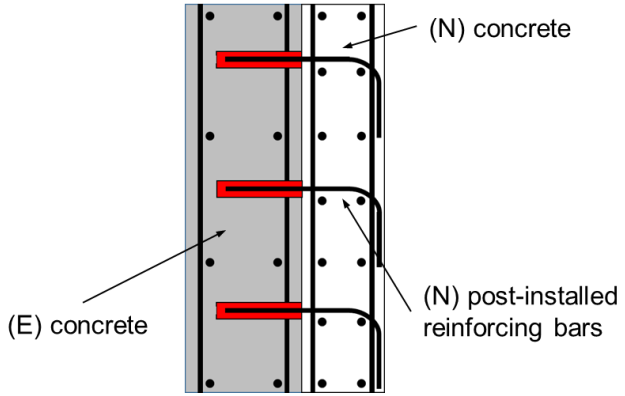
Bindirmeli Ekler (Splices)



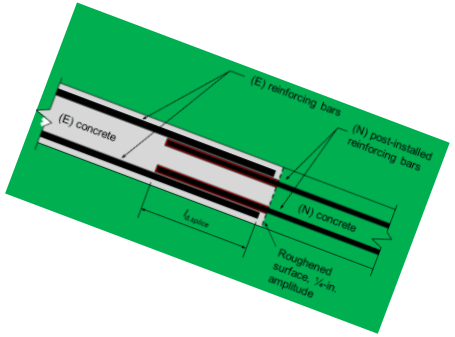
Yapısal Ekler (End Anchorages)



Beton Kaplama (Concrete overlay)



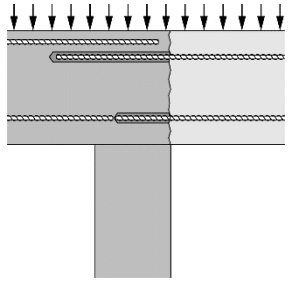
BINDIRMELI EKLER IÇIN MEVZUAT YAPıSı



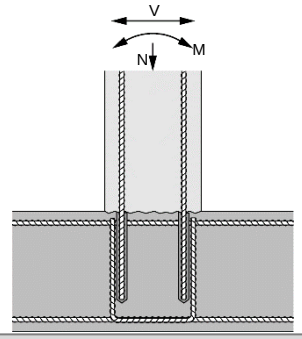
Bindirmeli Bağlantılar

	Statik	Yangın	Sismik
Ürün Değerlendirmesi	EAD 330087-00-0601		EAD 330087-01-0601 (Previously 331522
Teknik Data	ETA		
Tasarım Metodu	TS EN 1992-1-1		TS EN 1998

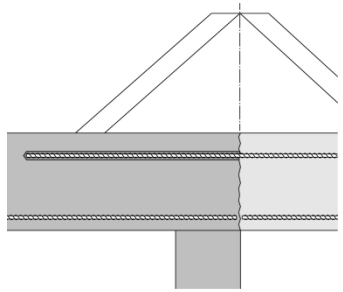
TS EN 1992-1-1 ILE YAPıLABILEN FILIZ EKIMI APLIKASYON TIPLERI



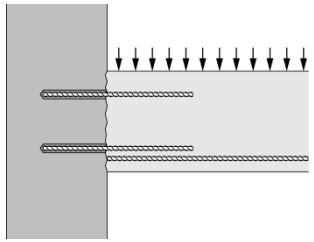
Overlap joint for rebar connections of slabs and beams



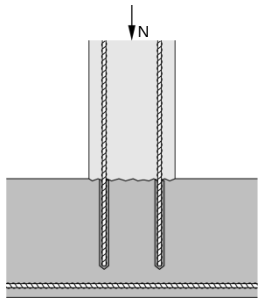
Overlap joint at a foundation of a column or wall



Anchoring of reinforcement to cover the line of acting tensile force



End anchoring of slabs or beams (simply supported)



Components stressed primarily in compression

TS EN 1992-1-1 ILE FILIZ EKIMI TASARıMı

$$l_{b,rqd} = \frac{\emptyset}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} \longrightarrow l_{bd} = l_{b,rqd} \cdot \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 . \alpha_6 \geq l_{b,min}$$

f_{bd} → $f_{bd,seism}$

Parameter	Value
α_1	1
α_2	0,7 - 1
α_3	1 (always even in the presence of transverce reinforcement)
α_4	1
α_5	0,7 - 1
α_6	1,5
$l_{b,rqd}$	$l_{b,rqd} = (\phi/4)(\sigma_{sd,seism}/f_{bd,seism})$ → using f_{yd} instead of $\sigma_{sd,seism}$ is strongly recommended
$l_{b,min}$	max(0.3. α_6 .$l_{brqd,fyd}$; 15ϕ; 200mm) → splices

KAHOOT! ZAMANı

AJANDA

1.0 Giriş ve Güçlendirme Adımları

2.0 Filiz Ekimi Nasıl Yapılır?

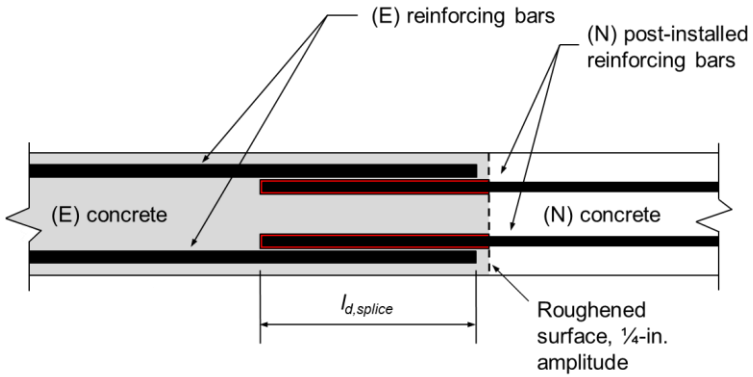
3.0 Bindirmeli Bağlantılar (Splices)

4.0 Yapısal Ekler (End Anchorages)

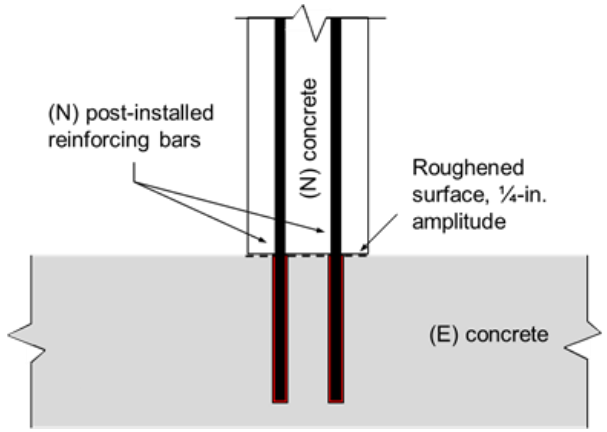
5.0 Kesit Kalınlaştırma (Concrete Overlay)

TASARıM AÇıSıNDAN FILIZ EKIMI GENEL OLARAK 3 ANA GRUBA AYRıLıR

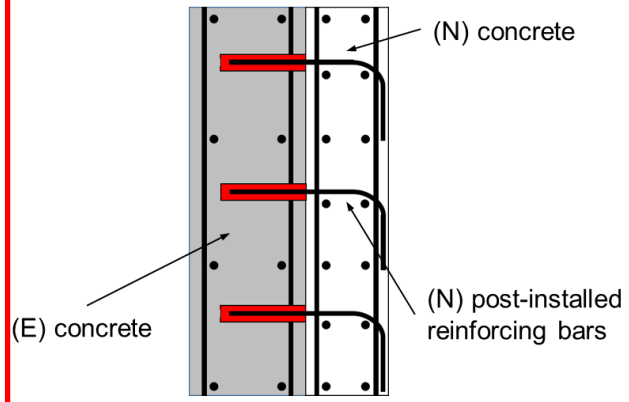
Bindirmeli Ekler (Splices)



Yapısal Ekler (End Anchorages)



Beton Kaplama (Concrete overlay)



YAPISAL EKLER IÇIN MEVZUAT YAPISI

Yapısal Ekler

	Statik	Sismik	Yangın
Ürün Değerlendirmesi	EAD 332402-00-0601	EAD 332402-00-0601-v02	NA
Teknik Data	ETA		
Tasarım Metodu	EOTA TR069		

EOTA TR 069

EOTA®

TECHNICAL REPORT

Design method for anchorage of post-installed reinforcing bars (rebars) with improved bond-splitting behavior as compared to EN 1992-1-1

TR 069
October 2019
Amended June 2021

1 SCOPE OF THE TECHNICAL REPORT

1.1 Abstract

This Technical Report (TR) provides a method for the design of post-installed reinforcing bars (rebars) in moment resisting connections where structural elements are cast at different times.

This TR is only applicable for post-installed rebar systems that hold European Technical Assessments (ETAs) based on EAD 332402-00-0601 [7], EAD 332402-00-0601-v01 [8] or EAD 332402-00-0601-v02 [9].

The design method included in this TR relies on characteristic resistances and parameters, as well as the intended working life, which are stated in the ETA based on EAD 332402-00-0601 [7], EAD 332402-00-0601-v01 [8] for static and quasi-static loading assuming a working life of 50 or 100 years, respectively, and EAD 332402-00-0601-v02 [9] for seismic actions.

1.1.1 Covered applications

The design procedure described in this Technical Report is applicable for moment-resisting connections subjected to static and quasi-static loading, as shown in Figure 1.1. Seismic, fatigue action, and fire exposure are not covered by this Technical Report.

The design requirements of this Technical Report cover both ultimate and serviceability limit states.

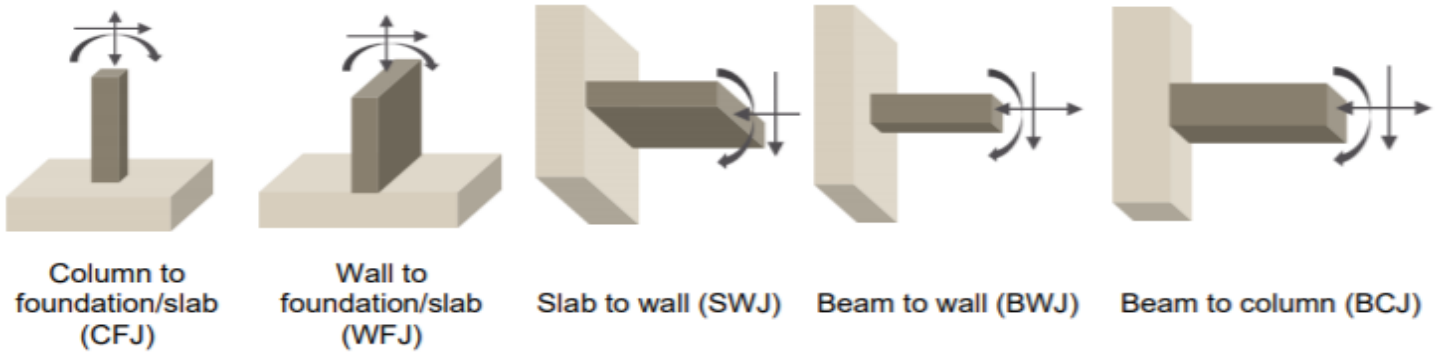
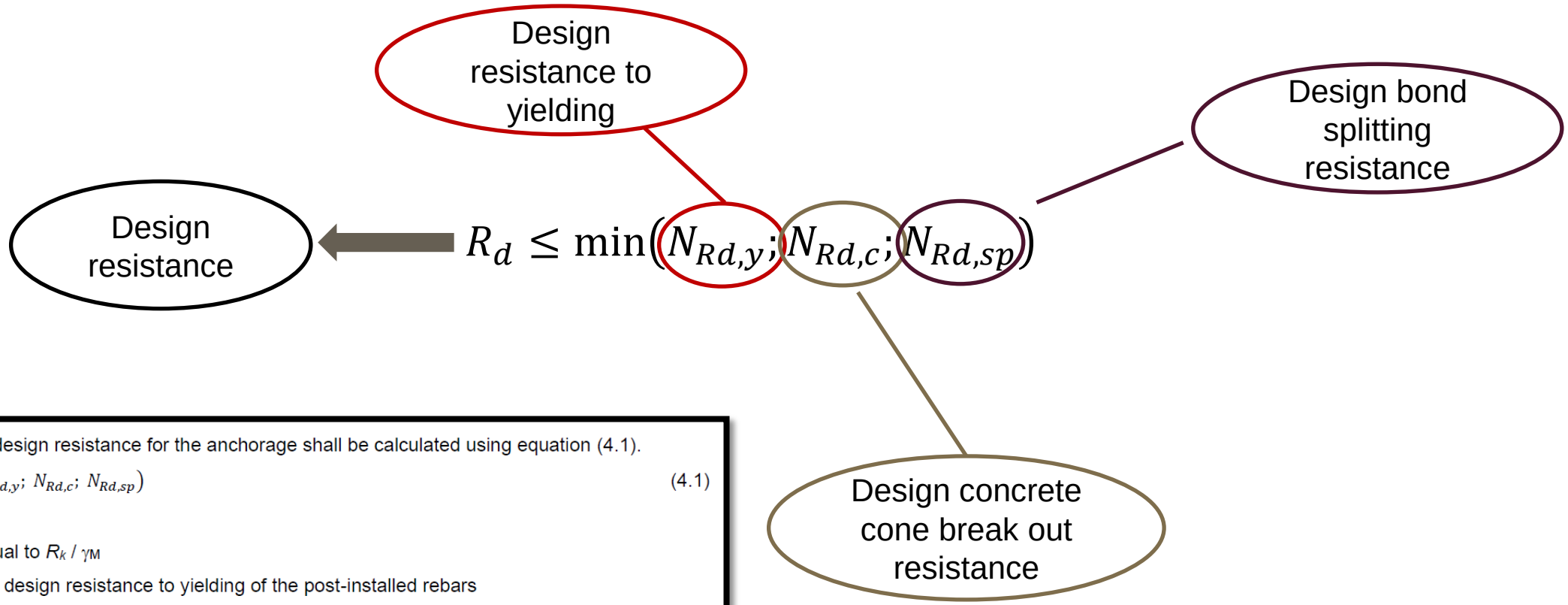


Figure 1.1: Structural moment resisting connections covered by this Technical Report
(clear grey: existing element; dark grey: new element)

STATIK DURUMDA YAPISAL EK TASARIMI



(2) The decisive design resistance for the anchorage shall be calculated using equation (4.1).

$$R_d = min(N_{Rd,y};\ N_{Rd,c};\ N_{Rd,sp}) \quad (4.1)$$

Where

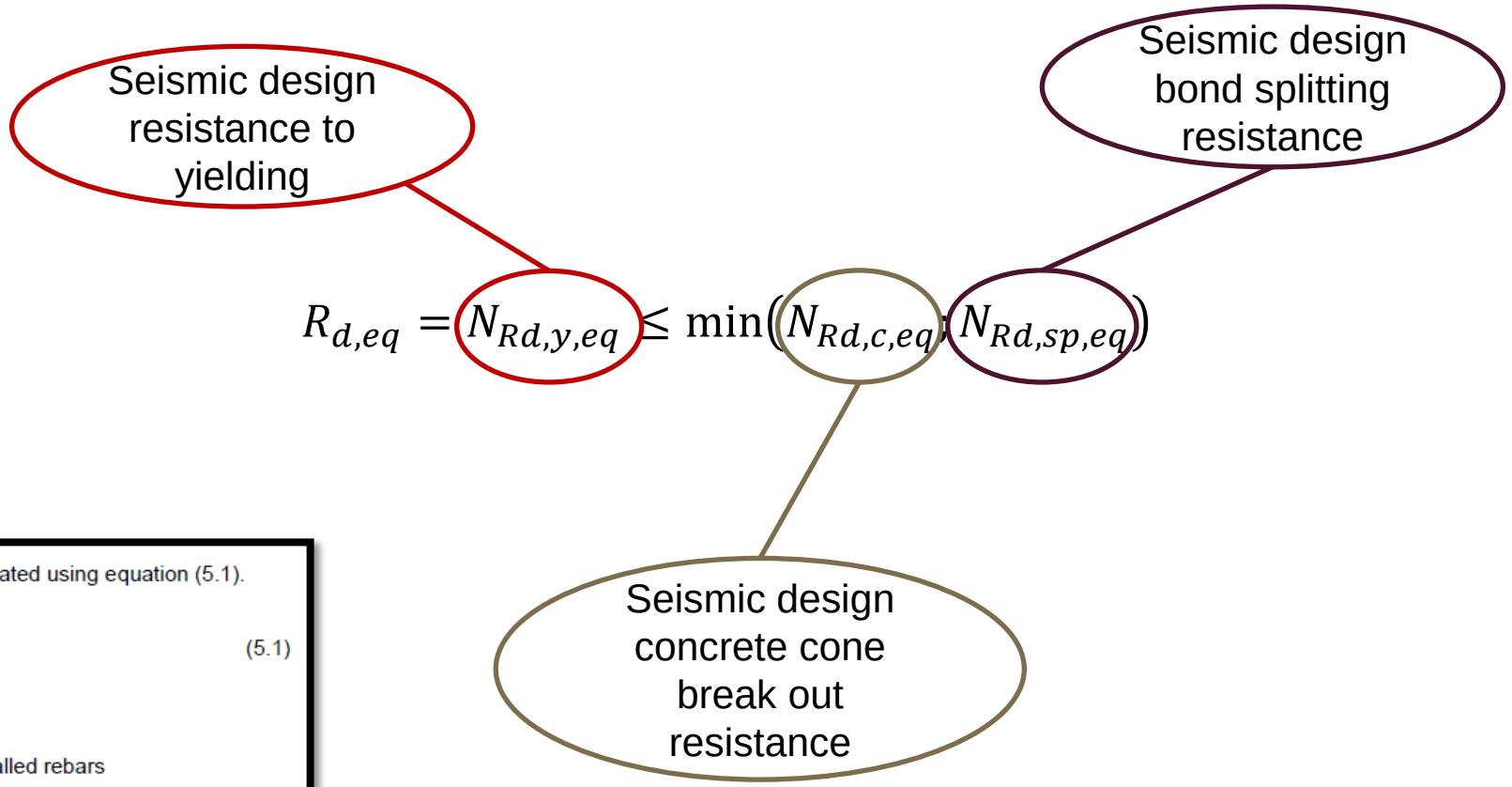
R_d is equal to R_k / γ_M

$N_{Rd,y}$ is the design resistance to yielding of the post-installed rebars

$N_{Rd,c}$ is the design concrete cone break-out resistance of the post-installed rebars

$N_{Rd,sp}$ is the design bond-splitting resistance of the post-installed rebars

SISMIK DURUMDA YAPISAL EK TASARIMI



(2) The decisive design resistance for the anchorage shall be calculated using equation (5.1).

$$R_{d,eq} = N_{Rd,y,eq} \leq min(N_{Rd,c,eq};\ N_{Rd,sp,eq}) \quad (5.1)$$

Where:

$R_{d,eq}$ is equal to $R_{k,eq} / \gamma_M$

$N_{Rd,y,eq}$ is the seismic design resistance to yielding of the post-installed rebars

$N_{Rd,c,eq}$ is the seismic design concrete cone break-out resistance of the post-installed rebars

$N_{Rd,sp,eq}$ is the seismic design bond-splitting resistance of the post-installed rebars

1) AKMAYA KARŞı DIRENÇ DEMIR ÇAPıNıN VE ÇELIK MUKAVEMETININ BIR FONKSIYONUDUR

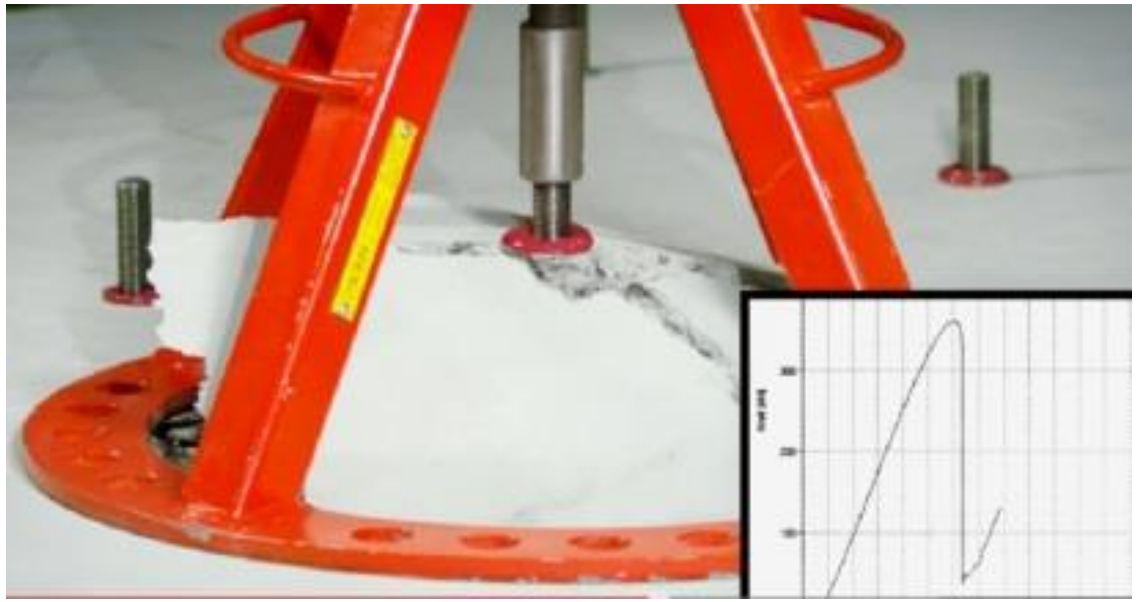
$$N_{Rd,y} = N_{Rk,y} / \gamma_{Ms}$$

$$N_{R\,k,y} = A_s \cdot f_{yk}$$

$$N_{R\,k,y,eq} = \gamma_{Rd} \cdot N_{R\,k,y}$$

γ_{Rd}= *1,0 and 1,2 for DCM and DCH,*

2) BETON KONIK KOPMAYA KARŞı DIRENÇ ÇEŞITLI PARAMETRELERIN FONKSIYONUDUR



$$N_{Rk,c} = N^{0}_{Rk,c} \cdot \frac{A_{c,N}}{A^{0}_{c,N}} \cdot \psi_{s,N} \cdot \psi_{ec,N} \cdot \psi_{re,N} \cdot \psi_{M,N}$$

$$N_{Rk,c,eq} = \alpha_{eq} . N_{Rk,c}$$

α_{eq}	=	1,0 if w_k = 0,3 mm
α_{eq}	=	0,85 if w_k > 0,3 mm

3) AYRILMAYA KARŞı DIRENÇ ÜRÜN PERFORMANSıNıN BIR FONKSIYONUDUR

$$N_{Rk,sp} = \tau_{Rk,sp} \cdot l_b \cdot \phi \cdot \pi$$

$$\tau_{Rk,sp} = \eta_1 \cdot A_k \cdot \left(\frac{f_{ck}}{25}\right)^{sp1} \cdot \left(\frac{25}{\phi}\right)^{sp2} \cdot \left[\left(\frac{c_d}{\phi}\right)^{sp3} \cdot \left(\frac{c_{max}}{c_d}\right)^{sp4} + k_m \cdot K_{tr}\right] \cdot \left(\frac{7\phi}{l_b}\right)^{lb1} \cdot \Omega_{p,tr}$$

$$\leq \tau_{Rk,ucr} \cdot \Omega_{cr,03}\ (or\ \Omega_{p,tr}) \cdot \psi_{sus} \qquad \text{for } 7\phi \leq l_b \leq 20\phi$$

$$\leq \tau_{Rk,ucr} \cdot \left(\frac{20\,\phi}{l_b}\right)^{lb1} \cdot \Omega_{cr,03}\ (or\ \Omega_{p,tr}) \cdot \psi_{sus} \qquad \text{for } l_b > 20\phi$$

$$\tau_{Rk,sp,eq} = \eta_1 \cdot \alpha_{eq,sp} \cdot A_k \cdot \left(\frac{f_{ck}}{25}\right)^{sp1} \cdot \left(\frac{25}{\phi}\right)^{sp2} \cdot \left[\left(\frac{c_d}{\phi}\right)^{sp3} \cdot \left(\frac{c_{max}}{c_d}\right)^{sp4} + k_m \cdot K_{tr}\right] \cdot \left(\frac{7\phi}{l_b}\right)^{lb1}$$

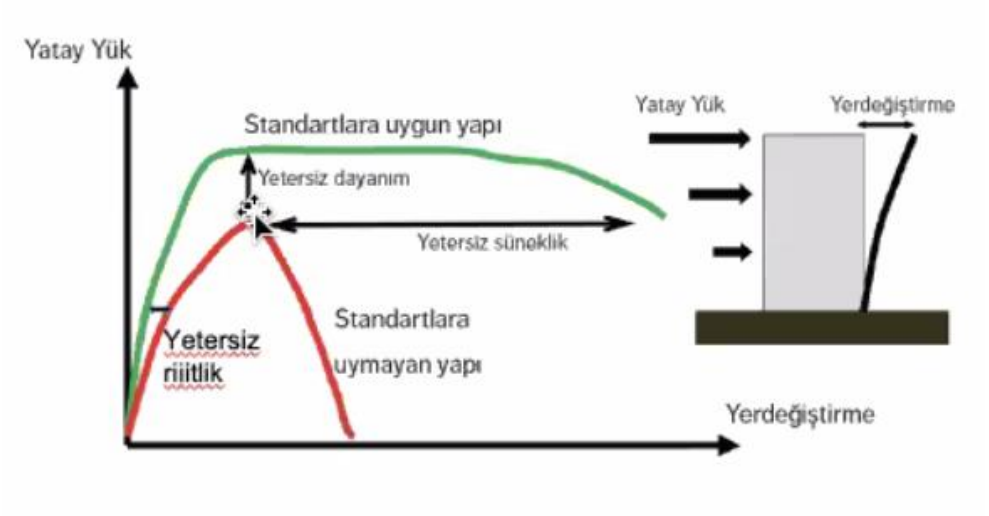
$$\leq \tau_{Rk,ucr} \cdot \Omega_{cr,eq} \cdot \alpha_{eq,p} \qquad \text{for } 7\phi \leq l_b \leq 20\phi$$

$$\leq \tau_{Rk,ucr} \cdot \left(\frac{20\,\phi}{l_b}\right)^{lb1} \cdot \Omega_{cr,eq} \cdot \alpha_{eq,p} \qquad \text{for } l_b > 20\phi$$

$\Omega_{cr,eq}$ = $\Omega_{cr,03}$ or $\Omega_{cr,05}$ or $\Omega_{cr,08}$ depending on the design assumptions (see Section 3.6) taken from the relevant ETA

$\alpha_{eq,sp}$ and $\alpha_{eq,p}$ are the seismic reduction factors for splitting and pull-out, respectively, taken from the relevant ETA

ÇATLAK GENIŞLIĞI IÇIN SÜNEKLIK SıNıFı BELIRLEYICIDIR



Ductility class according to EN 1998-1	Behaviour factor, q according to EN 1998-1	l_b / h [-]	Assumed crack width, w_k [mm]	Comment
DCL	1,0	All	0,3	Static design applies
DCM	1,0 – 1,5	≥ 0,8	0,3	
		< 0,8	0,5	
DCM / DCH	1,5 – 3,0	≥ 0,8	0,5	
		< 0,8	0,8	
DCM / DCH	> 3,0	≥ 0,8	0,8	
		< 0,8	Not covered by this TR	

TR069 SISMIK TASARIMLARINIZI YAPARKEN ÜRÜN ETA BELGESİNDEN FAYDALANIYORUZ

Table C2: Essential characteristics for reinforcing bars (rebars) under tension load in concrete under seismic action

Reinforcing bar (rebar)			ϕ8	ϕ10	ϕ12	ϕ13	ϕ14	ϕ16	ϕ18	ϕ20	ϕ22	ϕ24	ϕ25	ϕ28	ϕ30	ϕ32	ϕ36	ϕ40
Pull-out failure for working life of 50 and 100 years																		
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD**																		
Reduction factor for pull-out resistance under seismic action	$\alpha_{eq,p}$	[-]	0,61	0,83													0,65	
Influence of cracked concrete on bond resistance τ_{Rk} for working life of 50 and 100 years																		
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD**																		
Factor for influence of cracked concrete	$\Omega_{cr,05}$	[-]	0,79	0,81	0,82	0,83	0,84	0,82	0,78	0,76	0,73	0,71	0,70	0,68	0,66	0,65	0,62	0,60
	$\Omega_{cr,08}$	[-]	0,59	0,61	0,63	0,64	0,65	0,67	0,69	0,71	0,72	0,71	0,70	0,68	0,66	0,65	0,62	0,60
Bond-splitting failure for working life of 50 and 100 years																		
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD**																		
Reduction factor for bond-splitting resistance under seismic action	$\alpha_{eq,sp}$	[-]	0,95															

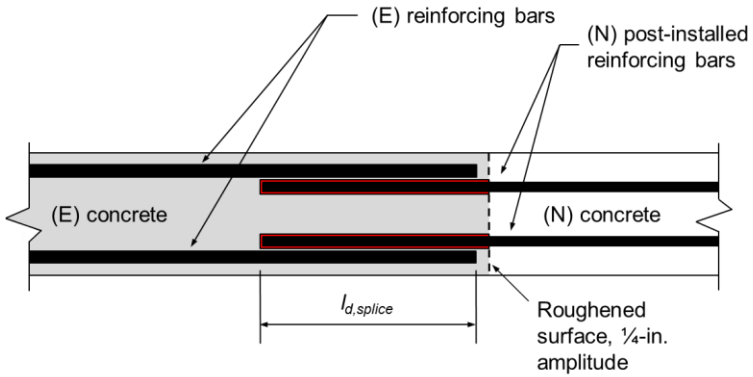
KAHOOT! ZAMANı

AJANDA

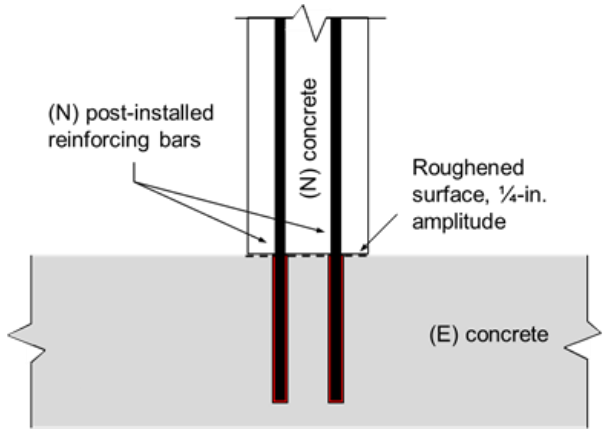
1.0 Giriş ve Güçlendirme Adımları
2.0 Filiz Ekimi Nasıl Yapılır?
3.0 Bindirmeli Bağlantılar (Splices)
4.0 Yapısal Ekler (End Anchorages)
5.0 Kesit Kalınlaştırma (Concrete Overlay)

TASARıM AÇıSıNDAN FILIZ EKIMI GENEL OLARAK 3 ANA GRUBA AYRıLıR

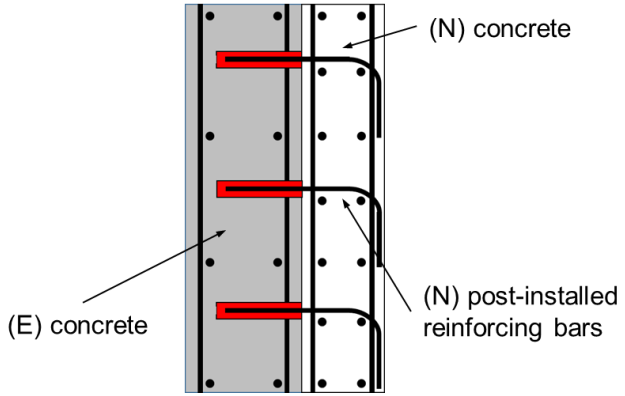
Bindirmeli Ekler (Splices)



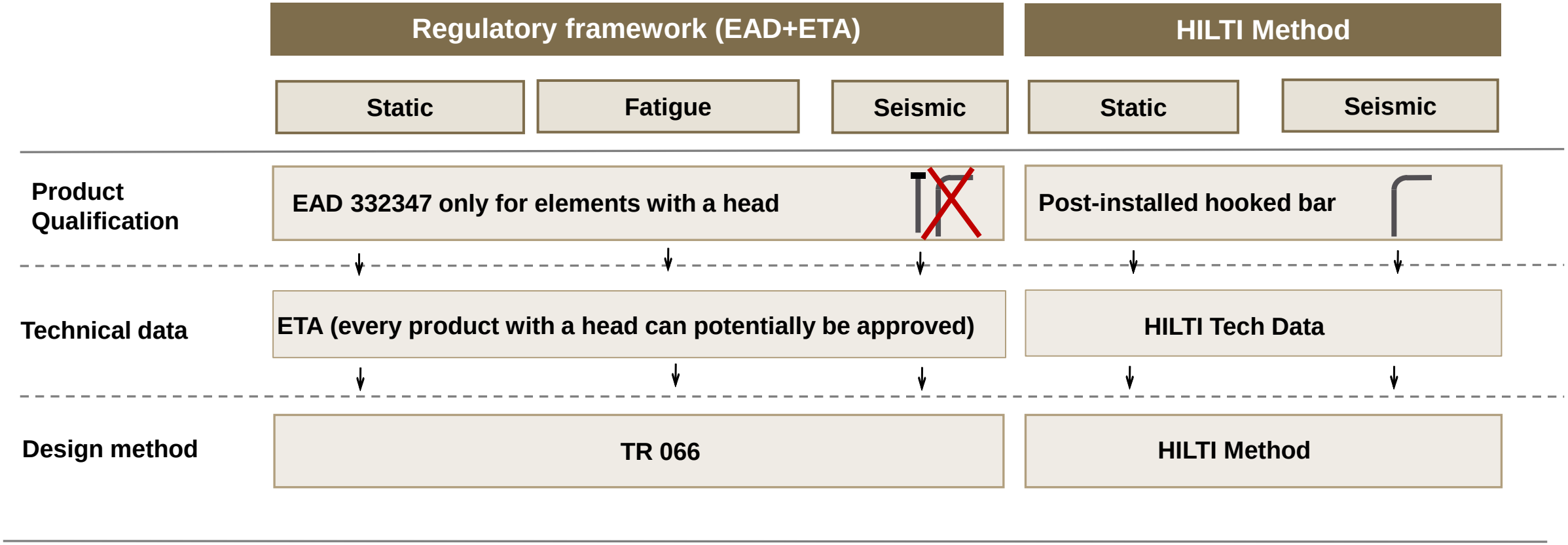
Yapısal Ekler (Structural joints)



Beton Kaplama (Concrete overlay)



MEVZUAT YAPISI: BAŞLIKLI ANKRAJ İÇİN EAD-TR066, DONATI İÇİN HILTI METODU

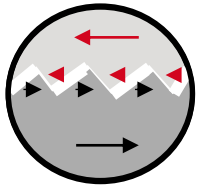


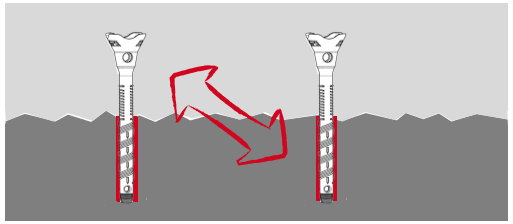
İKI BETON YÜZEY ARASINDAKİ KESME DAYANıMı (ZAYIF YAPIŞMA DAYANIMI) STATİK VE SİSMIK

$$\tau_{Rd} = c_r * f_{ck}^{\frac{1}{3}} + \mu * (\sigma_n + \kappa_1 * \alpha_{\kappa 1} * \rho * \sigma_s) + \kappa_2 * \alpha_{k2} * \rho * \sqrt{\frac{f_{y,k}}{\gamma_s} * \frac{0{,}85 * f_{ck}}{\gamma_c}} \leq \beta_c * \nu * \frac{0{,}85 * f_{ck}}{\gamma_c}$$

Eq. 2.11

1. **Interlock**
2. **Friction**
3. **Dowel action**
4. **Concrete strut resistance**





$$\tau_{Rd,seis} = \alpha_{seis}\left[c_r \cdot f_{ck}^{1/3} + \mu \cdot \sigma_n + \mu \cdot k_1 \cdot \alpha_{\kappa 1} \cdot \rho\ \sigma_{s,eq} + k_2 \cdot \alpha_{\kappa 2} \cdot \rho \cdot \sqrt{f_{yd} \cdot f_{cd}}\right] \leq \beta_c \cdot v \cdot f_{cd}$$

Eq. 3.2

α_{seis}= given in the European Technical Assessment of the connector in accordance with EAD 332347-00-0601-v01 [2]

$\sigma_{s,eq}$ = Steel stress associated with the relevant failure mode under seismic conditions;
$\sigma_{s,eq} = \min(N_{Rd,s,eq}; N_{Rd,p,eq}; \ldots) \leq f_{yk} / \gamma_s$

İKI BETON YÜZEY ARASINDAKİ KESME DAYANıMı– HILTI TASARıM METHODU

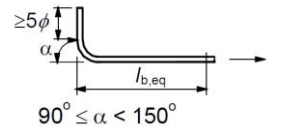
Proof: same as TR066

$$\tau_{Rd} = \underbrace{\mu_h \cdot (\sigma_n + \kappa_{1h} \cdot \rho \cdot \sigma_s)}_{1} + \underbrace{\kappa_{2h} \cdot \rho \cdot \sqrt{\frac{f_{yk}}{\gamma_s} \cdot \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}}}_{2} \leq \underbrace{\beta_c \cdot \nu \cdot \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}}_{3}$$

1. **Friction**
2. **Dowel action**
3. **Concrete strut resistance**

	k_{1h} static	k_{1h} seismic	k_{2h}			β_c
	$6d \leq h_{eff} \leq 20\,d$	$10d \leq h_{eff} \leq 20\,d$	$h_{eff} = 6d$	$6d \leq h_{eff} \leq 8d$	$h_{eff} > 8d$	
Rough (≥ 1.5 mm)	0.6	$0.02\frac{h_{eff}}{d} + 0.2$	0.5	$0.1\frac{h_{eff}}{d} - 0.1$	0.7	0.5
Smooth (< 1.5 mm)	0.4	0.20	0.5	$0.1\frac{h_{eff}}{d} - 0.1$	0.7	0.4

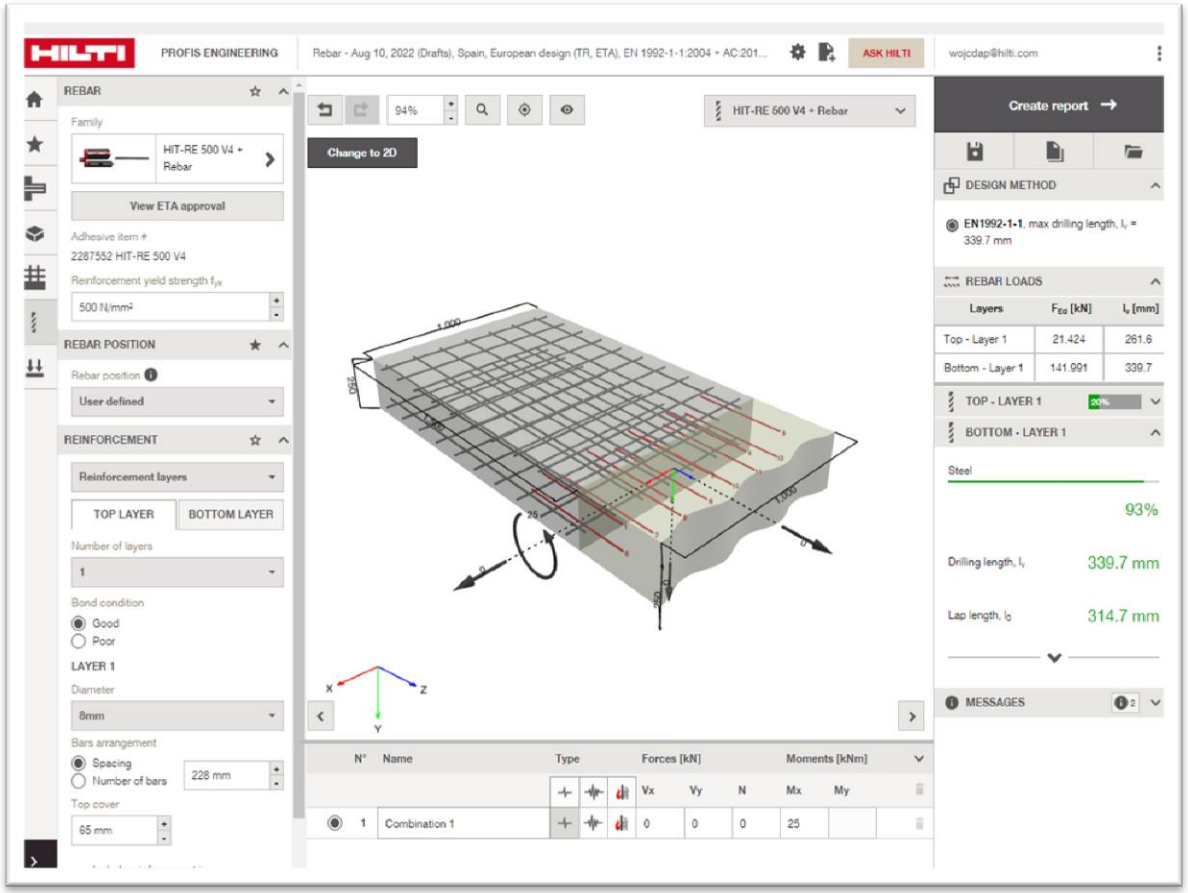
!Only reinforced interface
!Joint roughness: Rough or smooth
!Only hooked bars
8 to 25 mm static
10 to 20 mm seismic C1
16 – 18 mm seismic C2
(only RE500V4)

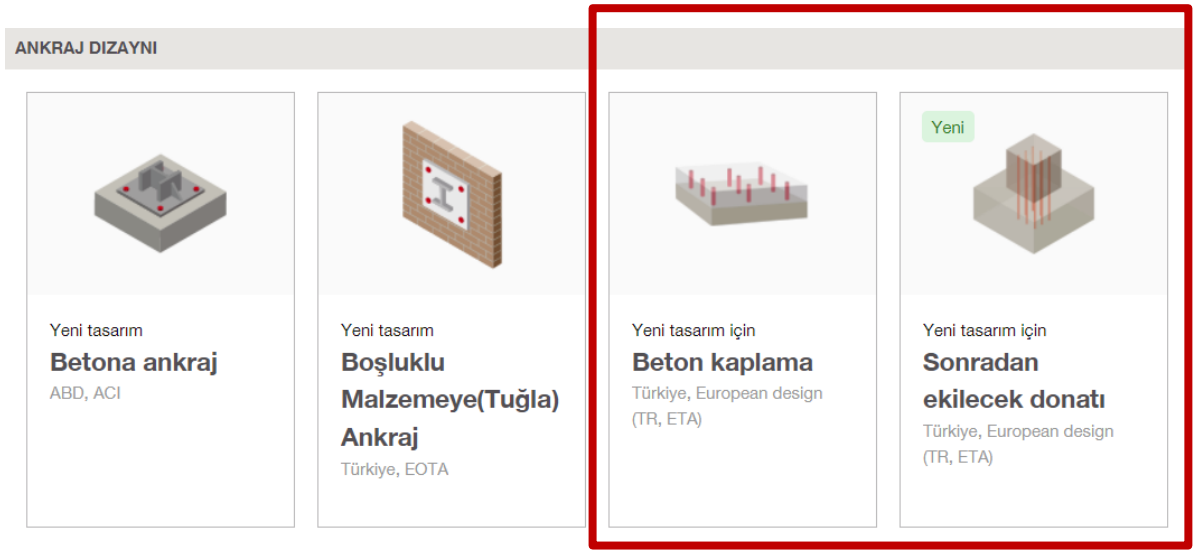


b) Equivalent anchorage length for standard bend

KAHOOT! ZAMANı

FİLİZ EKİMİ TASARIM YAZILIMI – PROFIS ENGINEERING





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